**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:
YARON MAYER at. al.
Serial No. 10/693,823
Filed: Oct. 23, 2003

**For: Membrane-less Microphone and/or speaker capable of functioning in a very wide range of frequencies and with much less distortions.**

Enclosed is the Israeli priority document for the above application.

Thank you very much,
Yaron Mayer May 21, 2008
Yaron Mayer

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משרד המשפטים

רשות הפטנטים

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| **Application No:** | **152439** | **מספר בקשה:** |
| **Date of application:** | **23/10/2002** | **תאריך הבקשה:** |

MEMBRANE-LESS MICROPHONE CAPABLE OFFUNCTIONING IN A VERY WIDE RANGE OFFREQUENCIES AND WITH MUCH LESS DISTORTIONS

מיקרופון ללא ממברנה המסוגל לעבוד בטווח תדרים רחב מאוד ועם הרבה פחות עיוותים

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**<u>Membrane-less Microphone capable of functioning in a very wide range of frequencies and with much less distortions.</u>**

# Membrane-less Microphone capable of functioning in a very wide range of frequencies and with much less distortions.

## Background of the invention

### Field of the invention:

The present invention relates to high quality recording, and more specifically to a high quality Membrane-less Microphone capable of functioning in a very wide range of frequencies without distortions, which can be at the same time very compact and much cheaper than the state-of-the-art high-end microphones. In some of the embodiments it can also be easily made directional or even very directional, and it is much less affected by electromagnetic interference.

### Background

Unlike computers, the field of Hi-Fi recording has advanced much more slowly, so that for example some systems existed even 20 or more years ago with quality not very different or even better than many systems that are sold today. One of the elements that hasn't changed much for example is the Microphone. Although normal microphones are very cheap, their range is usually limited up to around 10KHz and is typically not free from various distortions. Other microphones than can reach 20 KHz or close to it typically cost tens or hundreds of dollars and still have various limitations, and higher-end microphones, for example of the types needed for Live Music performance or for the Mass media broadcasting, such as Radio or TV, are typically much more expensive and can cost even thousands of dollars. The main reason for these limitations is the fact that normal Microphones use a membrane, which is a mechanical element, and therefore they are limited by the mechanical qualities of the membrane. In addition, normal dynamic electronic microphones use a sensitive coil that is affected by the movement of a magnetic element that is attached to the membrane, so the weak currents in the coil need significant amplification, and this coil is therefore susceptible to electromagnetic interference, for example in cars, and even shielding it with a metal mesh only partially solves the problem, because for example it cannot be fully electromagnetically shielded in the direction where the sound needs to come in. On the other hand, condenser microphones, which are based on a changing capacitor instead of a coil, typically have a more flat response on a wider frequency range than dynamic microphones, but they are still limited by the physical properties of the membrane, they are typically much more expensive, and they typically

suffer from much less tolerance to loud noise saturation. Even Passive reflective Optical Microphones, that have the advantage of being immune to electromagnetic interference, still need to use a membrane and thus still have the mechanical limitations imposed by the membrane itself, such as bandwidth limitations and varying response curves that depend on the frequency.

## Summary of the invention

The present invention discloses a novel type of microphone that is able to detect directly sound waves in the air without a membrane, and therefore has the advantage that it can function without distortions or at least with much less distortions than conventional microphones over a much wider range of frequencies, such as for example between 0 to 500KHz or other desirable ranges, giving a preferably more or less flat response, so that the sensitivity function is preferably similar over the entire range of frequencies. In addition, it does not use an electromagnetic sensing coil, so it is much less susceptible to electromagnetic interference. In addition, at least in some of the embodiments shown it can be made directional or even very directional as needed, and thus can be used for example in noisy environments. It can also be much more robust than ordinary microphones in being able to handle even very low sound levels up to very high sound levels, and can also have a very fast transient response. This is preferably accomplished in the following preferable ways:

1. The sensing of sound is preferably based on sensing the interferences or distortions that audible or higher sound waves create on one or more base signals that are preferably of a considerably higher frequency than audible sounds, such as for example a few hundred KHz or even 1 or more MHz. Unlike usual ultrasound sensing, where the signal is emitted and reflected back to the same place, preferably the sensor and the detector are separate. Another possible variation is that the same device is used both for generating the signal and for detecting back the altered signal. However, since unlike usual ultrasonic sensing, the sensed target is sound waves in the air itself, there is no normal reflection from the sensed target back into the emitting element. Therefore, either the sensor is on the other side after the signal has gone through the air, or for example the signal is reflected back to the direction of the emitter of the ultrasonic signal by a constant reflector, in which case any distortions caused by the reflector itself are preferably taken into account and ignored by the decoding algorithm, so this variation is less desirable, and also in this

variation the signal goes twice through the same air gap, which has to be taken into consideration. Preferably the air gap between the transmitter and the receiver is small enough to detect just 1 peak of the wave, so that for example if the desired detectable frequency range is for example up to 20KHz, preferably the gap is 1.7 cm or less, and if the desired detectable frequency is up to 70KHz, preferably the gap is 5mm or less. On the other hand, since the smaller gap contains also less peaks of the ultrasound wave, preferably the ultrasound frequency used is as high as possible in order to improve the resolution or sensitivity. The Ultrasonic signal or signals can be generated and/or detected for example by a Quartz crystal, or by a Piezoelectric ultrasonic sensor, or for example by newly available MEMS (Micro-Electro-Mechanical-Systems) silicon-based ultrasonic sensors (such as for example by Sensant Corp.), or by any other known means for creating and/or detecting ultrasonic waves. The new MEMS sensors have the advantage that they are more efficient at transferring electrical energy into acoustic energy, and they can be a 10,000 times more sensitive than comparable piezoelectric sensors. Also, they can work for example in the range of 200KHz-5MHz, compared to Piezoelectric devices, which typically work only in the range of 50-200KHZ, and also they can be cheaper and smaller than piezoelectric sensors, so preferably such MEMS are used at the highest possible frequency. (Actually the MEMS for example do use very little micron-scale membranes for the sensing and the transmitting, so at least in the embodiments that use them the microphone of the present invention is not entirely without a membrane, however they are used very differently that an ordinary membrane in a microphone to detect sounds indirectly). In case a Quartz crystal is used, its own natural frequency is preferably used as a base reference. The transmitted signal can be of any desired shape, such as for example a sine wave, and it can be for example a consecutive signal or for example based on very short pulses. The ultrasound beam or beams are preferably emitted all the time that the microphone is turned on. Another possible variation is that they are activated for example only when the microphone senses that any sound is available, for example by using at least one transmitter-sensor pair that is always active when the Microphone is on, or by using for example some other preferably small membrane for sensing that there is any sound activity. Another possible variation is that one or more pairs are always active when the microphone is on but on a very low level, and the level of the ultrasonic beam is immediately increased when the microphone

senses that any relevant sound is entering the system. Preferably the decoding of the detected interference is based on phase shifting detection, and this can be converted back to the detected sound frequency for example by deleting the phase-shifted signal from the base reference frequency, or by using an interferometer, or by using a feedback loop that changes the transmitted frequency, or by any other known means. Another possible variation is to detect for example in addition or instead also frequency shifting and/or any other distortions. The decoded signals can be for example analogue or digital, but the digital embodiment is more preferable because processing can be more easily done with a digital processor and because a digital signal that is transmitted from the microphone on an electrical wire is more immune to electromagnetic interference, even though the wire is preferably shielded in any case. If an analogue signal is used then it is preferably transmitted for example with frequency modulation or PWM (Pulse Width Modulation), in order to make it more immune to electromagnetic interference. One possible variation is using for example at least two baseline high-frequency signals, one that is isolated from the sound and one that is exposed to the sound, so that they can be compared. Another possible variation is using only one frequency that is exposed to the sound and comparing it for example to a digital representation of the original undistorted base high frequency that is for example pre-stored is the processor's memory. If for example 1 MHz is used as the base frequency, this can be used for example for detecting sound signals of up to 500KHz, which is half the wavelength, however, as explained above, preferably the ultrasound frequency is as high as possible. Another possible variation is to use for example as a reference baseline the normal interference pattern between one or more ultrasonic signals, and detect distortions as deviations from this interference pattern caused by normal sound waves in the air. Another possible variation is to use for example optical signals instead of the ultrasound signals, and detect for example the distortions that the varying air pressures (caused by the sound waves) have for example on an interference pattern of two or more light beams, so that the deviations of the normal interference pattern are detected, or for example detect the small Dopler shifts that this can cause. This variation might be called for example an optical microphone without a membrane. Another possible variation is to trap for example some preferably very small particles or for example ionized gas inside some enclosure and thus measure the changes in light caused by the movements of these minute particles. Another possible variation is to similarly use for

example other types of frequency, such as for example very high electromagnetic frequency. Of course various combinations of the above and other variations can also be used

2. Preferably the microphone is naturally at least partially directional, for example by putting the sensors inside a small acoustic tube, so that the tube itself allows more sounds to come in from its front than from its sides. Preferably the Microphone can be made even more directional by using a number of sensors and/or a number of high frequency sources inside the microphone, so that by taking into account the differential effect on them, the direction of the sound can be determined, and sounds from unwanted directions can be cancelled out for example by appropriate phase shifting. Another possible variation is to use for example this shifting in order to allow the user to electronically change the level of directionality and/or to electronically change the angle of input from which the sound is picked up. Preferably the default level of directionality is not too high, such as for example not more than a spread of 20 or 30 degrees, since otherwise for example the user's movements can cause the speech to fluctuate in and out of focus. Another possible variation is to use for example a Fourier transform in order to filter out the relevant directions. If MEMS sensors are used, the directionality control can be even easier, since each MEMS chip can use a large array of such sensors, so data from a number of different sensors can be used, for example even with the same transmitter-sensor pairs. Another possible variation is that the processor in this case is also integrated into the same chip, or for example the logic for the various processings needed by the microphone is integrated into the chip, for example as an ASIC. Another possible variation is that for example at least one MEMS miniscule drum is used within each transmitter and within each sensor, and they are arranged in pairs, and then preferably the integrating logic is across these chips. Of course various combinations of the above and other variations can also be used.

3. Preferably the microphone is very robust is terms of the range of volume levels it can detect, so that its high sensitivity allows it to detect audible sounds from very low levels up to high volume saturation. This is easily accomplished since in the embodiments that use for example the MEMS sensors these sensors can detect even very slight distortions created in the ultrasonic signal, so they can detect also very low volumes, and on the other hand if even very high sound levels are used, this will create larger distortions of

the ultrasound signal or signals but will not cause saturation problems, as can happen with conventional microphones that use a membrane. In addition, due to the fast reaction of the ultrasound sensors, the microphone can have also a very good transient response – which means that it can react very quickly to sudden changes in the sound.

4. Another possible variation is to use a similar process for example in reverse, so that interference patterns created between two or more high frequency sources can be used to create any lower-frequencies and volumes desired, thus creating also a membrane-less loudspeaker or earphone, preferably also with a broad frequency range and less distortions than ordinary speakers. In this case various frequencies that are created are preferably mixed together for example within a hollow resonance box. However, since normal interference changes the volume and not the frequency, preferably either multiple membranes are used with varying diameters, so that they can be vibrated at a large range of frequencies, or for example large arrays of minute membranes, for example MEMS membranes, are used and vibrated at all desired frequencies, with various combinations of vibrating membranes individually or with preferably high synchrony among them. This way, the high frequencies can be created for example very simply by vibrating the minute membranes, and lower frequencies can be simulated for example by slowly vibrating a large number of the minute membranes in synchrony, thus creating a simulation of one large slowly vibrating membrane. This has the further advantage that very compact high level speakers can be built this way, preferably with processor or computer control. Another possible variation is to use for example a normal type of speakers but to add one or more even smaller membrane than the usual tweeters, in order to display sound well above 20KHz, however the problem is that most people have very limited hearing above 20KHz. Another possible variation is automatically downshifting the higher frequencies, preferably digitally, so that for example if a guitar string can vibrate up to 70KHz, but humans can't hear these frequencies anyway, these frequencies can be for example downward converted, so that for example the range of 20-70KHz becomes correspondingly converted upon replay to a range of for example 20-22KHz or less, so that it preferably will appear to the listener as audible sounds at the high end of the pitch. Preferably the users have the ability to choose the desired range of the sound to be downshifted and/or preferably also the amount of

Another possible variation is for example to simply vibrate a large number of small membranes or elements in synchrony for any frequencies.

downshifting and/or the ratio of conversion (for example convert the 20-70KHz range down to a range of 2KHz or a range of 3 KHz, etc). This has the huge advantage that each user can adjust the sound playback so as to optimize his ability to hear according to his own limitations, so that for example someone who can hear well only up to 18KHZ will choose a lower downshifting and thus be able to hear fantastic sounds he has never been able to hear before, for example with music playback. Preferably this can be done either on the fly, for example in live concerts (however, in this case the users need headsets if the adjustable embodiment is used), and/or for example when playing back a recording. With recording preferably the down-conversion is done either during the recording or during the playback, or for example the user can have a choice about this, or some combination of the above. This can be used also for example in a communication device for exchanging sound with Dolphins or other animals that have a much different hearing and speaking range than ours. So since Dolphins can for example easily emit and hear sounds between 20KHz to 200KHz, another variation is to build for example a two-way automatic conversion system so that sounds that dolphins emit for example between 20KHz to 200KHZ are down-converted for example to sounds between 0-20KHZ, and sounds that the human emits back to the dolphins are up-shifted and preferably spread for example to a range of 20KHz-200KHz.

Of course various combinations of the above and other variations can also be used. This type of microphone can be very useful for example for recording live music, for high-quality recording for the mass media, such as TV or Radio interviews, and for noisy environments or environments where there are electromagnetic interferences, such as for example in cars. This can be especially important for example for use with Telematics systems in cars, which are interactive wireless information systems for cars which use interactive voice-based menus, since computer systems that can recognize spoken words are very sensitive to distortions, so normal microphones could be very problematic in cars both because of the noisy environment and because of their susceptibility to electromagnetic interference. An additional advantage is that apart from the high quality and frequency range, it can be much more lightweight and compact than the state-of-the art high-end microphones, so it can be much more convenient for example for a reporter who does field-work and needs to report from outside. Other possible applications are for example using this microphone with the more directional variations in a personal cellular remote speaking unit, that can be positioned for example

on a table at a distance of for example 1 meter or less from the user, or for example in a handheld cellular or mobile phone that can be held at a certain distance from the head (preferably in each of these cases together with a directional speaker). Another possible implementation is to use this microphone in better quality non-mobile phones or cellular phones or Internet phones. Although the frequency of transmitted speech in both non-mobile and cellular phones is typically limited to about 3KHz because of frequency utilization considerations, newer phones or cellular phones or Internet phones might be for example be based on TCP/IP and High digital condensation ratio such as for example DSP-based MP3 or other high-condensation algorithms, and then higher frequencies might be used. Another implementation is using this microphone for example for various army uses, where sometimes frequencies of even up to a few hundred KHz or more need to be detected, for example to monitor sounds created by various devices. In this case, preferably the detected sounds can be for example displayed visually, or downshifted to a more audible range, as explained above. Of course, various combinations of the above and other variations can also be used.

## Brief description of the drawings

**Figs. 1a-b** are illustrations of Sensant's miniscule ultrasound emitters/sensors built on the surface of Silicon.

**Figs. 2a-b** are illustrations of two possible variations of using transmitter-sensor pairs.

**Fig. 3** is an illustration of a phase-shift view on a scope.

## Important Clarification and Glossary:

**All these drawings are exemplary drawings. They should not be interpreted as literal positioning, shapes, angles, or sizes of the various elements. Throughout the patent when variations or various solutions are mentioned, it is also possible to use various combinations of these variations or of elements in them, and when combinations are used, it is also possible to use at least some elements in them separately or in other combinations. These variations are preferably in different embodiments. In other words: certain features of the invention, which are described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are**

**described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.**

## Detailed description of the preferred embodiments

All of the descriptions in this and other sections are intended to be illustrative examples and not limiting.

**Referring to Figs. 1a-b,** we show an illustration of Sensant's miniscule ultrasound emitters/sensors built on the surface of Silicon, as quoted from http://www.sensorsmag.com/articles/0200/17/main.shtml
As can be seen, the Silicon sensors resemble tiny drums with a thin, ultrasensitive nitride membrane that vibrates to send and receive ultrasound. The membrane and the underlying silicon substrate form the top and bottom plates of a capacitor. Changes in the voltage on the capacitor displaces the nitride membrane, and displacements of the membrane cause detectable changes in capacitance. As explained above in the summary, these sensor and emitters have the advantage that they are more efficient at transferring electrical energy into acoustic energy, and they can be a 10,000 times more sensitive than comparable piezoelectric sensors. Also, they can work for example in the range of 200KHz-5MHz, compared to Piezoelectric devices, which typically work only in the range of 50-200KHZ, and also they can be cheaper and smaller than piezoelectric sensors. Preferably the air gap between the transmitter and the receiver is small enough to detect just 1 peak of the wave, so that for example if the desired detectable frequency range is for example up to 20KHz, preferably the gap is 1.7 cm or less, and if the desired detectable frequency is up to 70KHz, preferably the gap is 5mm or less. On the other hand, since the smaller gap contains also less peaks of the ultrasound wave, preferably the ultrasound frequency used is as high as possible in order to improve the resolution or sensitivity. Since higher ultrasonic frequency means more ultrasonic peaks within the small needed gap between the transmitter and the sensor, preferably such MEMS are used at the highest possible frequency. In the embodiments that use such MEMS, one or more such miniscule drums can be used for each transmitter and for each sensor, and the whole set of transmitter-sensor pairs can either reside for example on one special integrated MEMS chip, or for example each pair can reside on one MEMES chip, or for example each individual transmitter and each individual sensors is based on one or more MEMS elements. Another possible variation is to use for example more sensors than transmitters or more transmitters than sensors. But preferably each sensor is paired with one transmitter and at least one such pair is used. Preferably the ultrasonic beam between them

is very narrow and directional so as to increase the efficiency and avoid disturbances between pairs if more than one pair is used, as explained below in the reference to Figs. 2a-b. This is easy to accomplish since these miniscule drums have a very directional beam and are very small. Of course this is just one example of a possible implementation, and many other possible variations of preferably minute ultrasonic emitters and sensors can also be used. Also, as explained in clause 4 in the patent summary, another possible variations is to create also wide-frequency band speakers by using for example an array or matrix of a preferably large number of these drums and vibrate them at all desired frequencies, with various combinations of vibrating membranes individually or with preferably high synchrony among them. This way, the high frequencies can be created for example by simply vibrating the minute membranes, and lower frequencies can be simulated for example by slowly vibrating a large number of the minute membranes in synchrony, thus creating a simulation of one large slowly vibrating membrane. Preferably the number of membranes used changes gradually depending on the frequency, so that the lower the frequency the more membranes are activated. This has the further advantage that very compact high level speakers can be built this way, preferably with processor or computer control. The minute membranes don't have to be circle-shaped but can be also for example rectangular or with more than 4 sides.

**Referring to Figs. 2a-b,** we show illustrations of two preferable variations of using transmitter-sensor pairs. Fig. 2b is a side view cross-section, in which the microphone is in some depth inside an acoustic tube (20) and only one pair of ultrasound transmitter (21a) and sensor (21b) is used. The acoustic tube itself can thus serve as a constrictive boundary, thus defining in general the shape of sound beam 24. Another possible variation is to use for example some parabolic sound reflector around the pair or pairs instead of just a tube. Fig. 1a is a top view of a preferable variation in which 3 transmitter-sensor pairs are used (pair 21 with transmitter 21a and sensor 21b, pair 22 with transmitter 22a and sensor 22b, and pair 23 with transmitter 23a and sensor 23b). As shown in the illustration, preferably the pairs are arranged so that the directions of the beams do not interfere with the other pairs and preferably the distances among the pairs are bigger than the gaps within the pairs. The sensors and/or the transmitters can be for example suspended inside the microphone in mid-air for example by thin wires, so as not to obstruct the passage of lower frequency waves. Another possible variation is that in order to further reduce disturbances each sensor can be for example encased in some wider envelope or for example some parabolic enclosure that absorbs or concentrates any residual parts of the ultrasound beam.

Another possible variation is that each pair is within a hole in some surface so that there is more isolation between the pairs, however this has the disadvantage that waves with lower frequencies might be able to only partially penetrate these holes. By using a larger distance among the 3 pairs, better directionality control can be obtained, as explained in above clause 2 of the patent summary, and also the microphone can be even more optimal also for lower frequencies. Therefore, the microphone can be for example relatively flat, and with a diameter of a few centimeters or more or less. The pairs can be for example at the top surface of the microphone, so that no acoustic walls are used to create directionality, and then preferably all directionality is achieved by the electronics that takes into account the different reaction of the pairs depending on direction. This has the advantage that the microphone can be flexibly changed from almost omni-directional to very directional, however is has the disadvantage that no automatic directionality is added by the walls. Another possible variation is that the surface that contains the pairs is lower inside the acoustic walls of the microphone, or for example this surface is movable and is for example automatically adjusted in addition or instead of the electronically achieved directionality, when the user adjusts the directionality. Preferably at least 3 pairs are used in order to achieve proper directionality control, however of course more than 3 can also be used. Another possible variation is to use for example some combination of Fig. 2a and Fig. 2b, so that for example both the top 3 pairs exist and one or more surfaces of a more inner pair or pairs also exist, and the microphone can for example automatically choose which of the pairs or sets of pairs to use according to the directionality adjustments requested by the user. Another possible variation is to use for example a number of types of pairs within each surface or at different surfaces, or for example more sensors than transmitters, so that the farther sensors are used for sensing lower frequencies and the smaller pair gaps are used for sensing higher frequencies. This should be no problem since for example the MEMS sensors and transmitters should be very cheap. Preferably the microphone is able to automatically filter out, preferably electronically, undesired frequencies according to the speed of the phase shifts (and/or the speed of any other detected distortions), so that for example very low phase shifts such as those caused for example by wind or breathing or other air flows are preferably ignored.

**Referring to Fig. 3,** we show an illustration of a phase-shift view on a scope. Since the phase-shifts caused by the sounds in the described embodiments are typically very small and fast, it is difficult to see them on a scope. However, by using as high as possible ultrasound frequency and thus increasing the number of ultrasound wave peaks within the

preferably small gap between the transmitter and the sensor, it is possible to take the sum of the phase shifts and measure it very accurately and very fast.

**While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications, expansions and other applications of the invention may be made which are included within the scope of the present invention, as would be obvious to those skilled in the art.**

## CLAIMS

We claim:

1. A system for detecting sounds at a wide range of frequencies, by using at least one beam of much higher frequency, which is distorted by the sound waves, and detecting the created distortions.

2. The system of claim 1 wherein said higher frequency is light and the detected distortions are any of phase shift or Dopler shift or distortions in an interference pattern between at least two light beams, or changes in light caused by the movements of some small particles, or any other detectable distortion.

3. The system of claim 1 wherein said higher frequency is electromagnetic radiation and the detected distortions are any of phase shift or frequency shift or distortions in an interference pattern between at least two radiation sources or any other detectable distortion.

4. The system of claim 1 wherein said higher frequency is ultrasound and the detected distortions are any of phase shift or frequency shift or distortions in an interference pattern between at least two ultrasound beams or any other detectable distortion.

5. The system of claim 4 wherein said ultrasound is transmitted and detected by any of Quartz crystals, Piezoelectric ultrasonic sensors, or MEMS sensors, or by any other known means for creating or detecting ultrasonic waves.

6. The system of any of the above claims wherein the air gap between the transmitter and the receiver is small enough to detect just 1 peak of the sound waves.

7. The system of any of the above claims wherein the much higher frequency used is as high as possible in order to improve the resolution and sensitivity by increasing the number of peaks of the high frequency signal within the gap.

8. The system of any of the above claims wherein the high frequency signals are consecutive.

9. The system of any of the above claims wherein the high frequency signals are based on pulses.

10. The system of any of the above claims wherein the at least one high frequency is emitted all the time that the microphone is turned on.

11. The system of any of the above claims wherein the at least one high frequency is activated or increased from lower levels only when the microphone senses that any sound has entered the system.

12. The system of any of the above claims wherein the detection is phase shifting detection, and the distortions are converted to the detected sound frequency by any of: deleting the phase-shifted signal from the base reference frequency, using an interferometer, or using a feedback loop that changes the transmitted frequency.

13. The system of any of the above claims wherein the decoded signals are digital.

14. The system of any of the above claims wherein the decoded signals are analogue and are encoded by any of frequency modulation or Pulse Width Modulation, in order to make it more immune to electromagnetic interference.

15. The system of any of the above claims wherein the microphone is naturally at least partially directional by putting the sensors inside any of an acoustic tube or parabolic sound reflector.

16. The system of any of the above claims wherein the microphone can be made directional by using any of a number of sensors and a number of high frequency sources inside the microphone, so that by taking into account the differential effect on them, the direction of the sound can be determined, and sounds from unwanted directions can be cancelled out.

17. The system of claim 16 wherein any of the directionality of the microphone and the actual direction chosen can be flexibly changed by the user.

18. The system of claim 15 wherein the directionality can be flexibly changed by the user by changing the sensors and transmitters depth within the acoustic walls.

19. The system of any of the above claims wherein interference patterns created between at least two high frequency sources can be used to create lower-frequencies and volumes desired.

20. The system of any of the above claims wherein for reproducing sound at a wide frequency range large arrays of minute membranes are used and vibrated at all desired frequencies, with various combinations of synchronously and separately vibrating membranes.

21. A speaker for reproducing sound at a wide frequency range wherein large arrays of minute membranes are used and vibrated at all desired frequencies, with various combinations of synchronously and separately vibrating membranes.

22. The system of any of claims 20 and 21 wherein for higher frequencies fewer membranes are vibrated and for lower frequencies more membranes are vibrated together in synchrony in order to create a simulation of a larger membrane.

23. The system of any of the above claims wherein for displaying high frequencies that are hard to hear the too high frequencies are automatically downshifted to frequencies that can be heard.

24. The system of claim 23 wherein the user has control on any of the range of frequencies to be downshifted, the amount of displacement, and the width of the downshifted frequencies.

25. The system of claim 23 wherein the downshifting can be used also with recordings, any of during the recording or during the playback.

26. The system of any of the above claims wherein two-way downshifting and up-shifting is used so that low humanly audible frequencies can be any of shifted and spread to higher ranges and higher ranges can be shifted to lower ranges.

27. The system of claim 26 wherein this is used for communications between humans and animals that can use and hear much higher sound frequencies.

28. The system of any of the above claims wherein the microphone is used for better speech quality together with high-efficiency condensation over any of normal telephone lines or cellular phones or Internet Phones.

29. The system of any of the above claims wherein each sensor is paired with one transmitter and at least one such pair is used.

30. The system of claim 29 wherein the high frequency beam within each pair is very narrow and directional.

31. The system of claim 29 wherein the pairs are arranged so that the directions of the beams do not interfere with the other pairs and the distances among the pairs are bigger than the gaps within the pairs.

32. The system of claim 29 wherein the sensors and transmitters are suspended inside the microphone in mid-air by wires, so as not to obstruct the passage of lower frequency waves.

33. The system of claim 29 wherein each transmitter-sensor pair is within a hole in some surface so that there is more isolation between the pairs.

34. The system of any of the above claims when more than one surface with sensors and transmitters is used.

35. The system of any of the above claims wherein more than one size of within-pair gaps is used, so that the farther sensors are used for sensing lower frequencies and the smaller pair gaps are used for sensing higher frequencies.

36. The system of any of the above claims the microphone is able to automatically filter out undesired frequencies according to the speed of the distortions.

37. The system of claim 36 wherein low frequencies caused by air flows are automatically filtered out.

38. A method for detecting sounds at a wide range of frequencies, by using at least one beam of much higher frequency, which is distorted by the sound waves, and detecting the created distortions.

39. The method of claim 38 wherein said higher frequency is light and the detected distortions are any of phase shift or Dopler shift or distortions in an interference pattern between at least two light beams, or changes in light caused by the movements of some small particles, or any other detectable distortion.

40. The method of claim 38 wherein said higher frequency is electromagnetic radiation and the detected distortions are any of phase shift or frequency shift or distortions in an interference pattern between at least two radiation sources or any other detectable distortion.

41. The method of claim 38 wherein said higher frequency is ultrasound and the detected distortions are any of phase shift or frequency shift or distortions in an interference pattern between at least two ultrasound beams or any other detectable distortion.

42. The method of claim 41 wherein said ultrasound is transmitted and detected by any of Quartz crystals, Piezoelectric ultrasonic sensors, or MEMS sensors, or by any other known means for creating or detecting ultrasonic waves.

43. The method of any of the above claims wherein the air gap between the transmitter and the receiver is small enough to detect just 1 peak of the sound waves.

44. The method of any of the above claims wherein the much higher frequency used is as high as possible in order to improve the resolution and sensitivity by increasing the number of peaks of the high frequency signal within the gap.

45. The method of any of the above claims wherein the high frequency signals are consecutive.

46. The method of any of the above claims wherein the high frequency signals are based on pulses.

47. The method of any of the above claims wherein the at least one high frequency is emitted all the time that the microphone is turned on.

48. The method of any of the above claims wherein the at least one high frequency is activated or increased from lower levels only

when the microphone senses that any sound has entered the method.

49. The method of any of the above claims wherein the detection is phase shifting detection, and the distortions are converted to the detected sound frequency by any of: deleting the phase-shifted signal from the base reference frequency, using an interferometer, or using a feedback loop that changes the transmitted frequency.

50. The method of any of the above claims wherein the decoded signals are digital.

51. The method of any of the above claims wherein the decoded signals are analogue and are encoded by any of frequency modulation or Pulse Width Modulation, in order to make it more immune to electromagnetic interference.

52. The method of any of the above claims wherein the microphone is naturally at least partially directional by putting the sensors inside any of an acoustic tube or parabolic sound reflector.

53. The method of any of the above claims wherein the microphone can be made directional by using any of a number of sensors and a number of high frequency sources inside the microphone, so that by taking into account the differential effect on them, the direction of the sound can be determined, and sounds from unwanted directions can be cancelled out.

54. The method of claim 53 wherein any of the directionality of the microphone and the actual direction chosen can be flexibly changed by the user.

55. The method of claim 52 wherein the directionality can be flexibly changed by the user by changing the sensors and transmitters depth within the acoustic walls.

56. The method of any of the above claims wherein interference patterns created between at least two high frequency sources can be used to create lower-frequencies and volumes desired.

57. The method of any of the above claims wherein for reproducing sound at a wide frequency range large arrays of minute membranes are used and vibrated at all desired frequencies, with various

combinations of synchronously and separately vibrating membranes.

58. A speaker for reproducing sound at a wide frequency range wherein large arrays of minute membranes are used and vibrated at all desired frequencies, with various combinations of synchronously and separately vibrating membranes.

59. The method of any of claims 57 and 58 wherein for higher frequencies fewer membranes are vibrated and for lower frequencies more membranes are vibrated together in synchrony in order to create a simulation of a larger membrane.

60. The method of any of the above claims wherein for displaying high frequencies that are hard to hear the too high frequencies are automatically downshifted to frequencies that can be heard.

61. The method of claim 60 wherein the user has control on any of the range of frequencies to be downshifted, the amount of displacement, and the width of the downshifted frequencies.

62. The method of claim 60 wherein the downshifting can be used also with recordings, any of during the recording or during the playback.

63. The method of any of the above claims wherein two-way downshifting and up-shifting is used so that low humanly audible frequencies can be any of shifted and spread to higher ranges and higher ranges can be shifted to lower ranges.

64. The method of claim 63 wherein this is used for communications between humans and animals that can use and hear much higher sound frequencies.

65. The method of any of the above claims wherein the microphone is used for better speech quality together with high-efficiency condensation over any of normal telephone lines or cellular phones or Internet Phones.

66. The method of any of the above claims wherein each sensor is paired with one transmitter and at least one such pair is used.

67. The method of claim 66 wherein the high frequency beam within each pair is very narrow and directional.

68. The method of claim 66 wherein the pairs are arranged so that the directions of the beams do not interfere with the other pairs and the distances among the pairs are bigger than the gaps within the pairs.

69. The method of claim 66 wherein the sensors and transmitters are suspended inside the microphone in mid-air by wires, so as not to obstruct the passage of lower frequency waves.

70. The method of claim 66 wherein each transmitter-sensor pair is within a hole in some surface so that there is more isolation between the pairs.

71. The method of any of the above claims when more than one surface with sensors and transmitters is used.

72. The method of any of the above claims wherein more than one size of within-pair gaps is used, so that the farther sensors are used for sensing lower frequencies and the smaller pair gaps are used for sensing higher frequencies.

73. The method of any of the above claims the microphone is able to automatically filter out undesired frequencies according to the speed of the distortions.

74. The method of claim 73 wherein low frequencies caused by air flows are automatically filtered out.

**Fig. 1a**

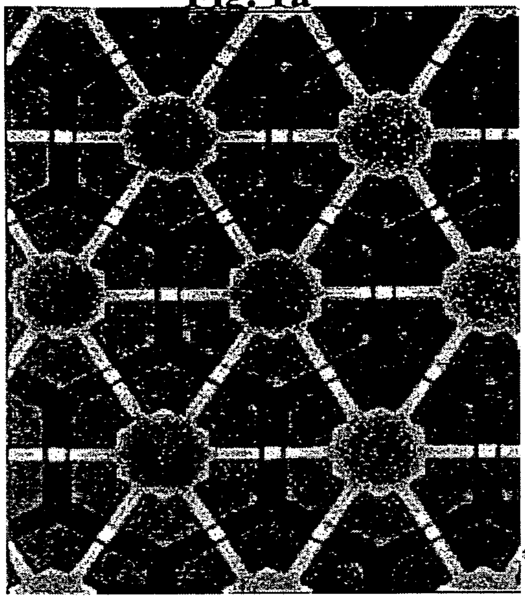

**Fig. 1b**

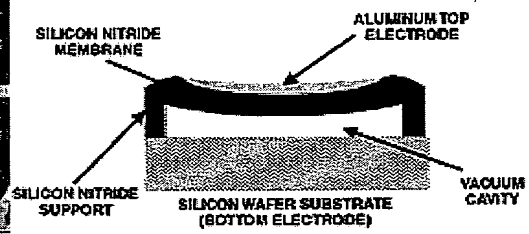


**Fig. 2a**

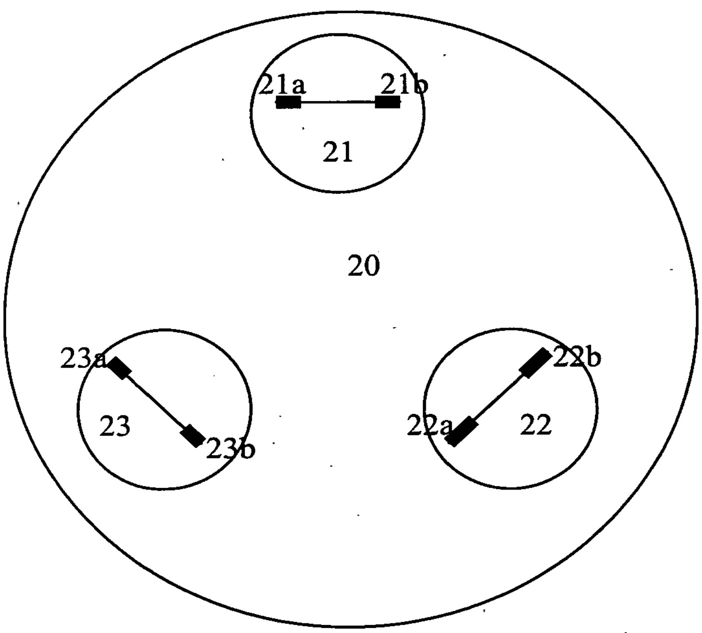


**Fig. 2b**

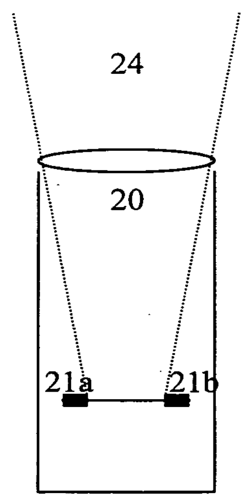

**Fig. 3**